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Load-carrying means for cable-operated elevators with an integrated load measurement device

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(54) Title: LOAD-CARRYING MEANS FOR CABLE-OPERATED ELEVATORS WITH AN INTEGRATED LOAD MEASUREMENT DEVICE

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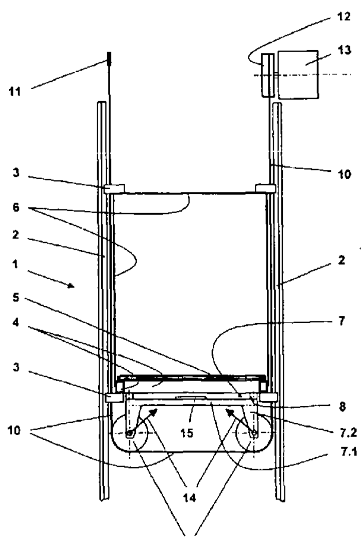

(57) Abstract: A load-carrying means (1) for cable-operated elevators comprising an under-loop cable arrangement is equipped with a load measurement device. At least one of the pulleys mounted underneath the load-carrying means (1) is fixed to said load-carrying means by a support structure containing an elastic element (7.1, 16, 22) which is deformed by the load-dependant cable forces exerted on the pulley(s) (9). A single sensor (15, 16) determines the extent of this deformation and produces a corresponding signal representing the weight of the load-carrying means (1) as the input for the elevator control system.

(57) Zusammenfassung: Ein Lastaufnahmemittel (1) für Seilaufzüge mit Unterschlingungs-Seilanordnung ist mit einer Lastmesseinrichtung ausgerüstet, bei der mindestens eine der unter dem Lastaufnahmemittel (1) angebrachten Seilrollen über eine Stützkonstruktion am Lastaufnahmemittel befestigt ist, welche ein elastisches Element (7.1, 16, 22) enthält, das durch die auf die Seilrolle(n) (9) wirkenden lastabhängigen Seilkräfte verformt wird. Ein einziger Sensor (15, 16) erfasst die Grösse dieser Verformung und erzeugt ein entsprechendes, das Gewicht des Lastaufnahmemittels (1) repräsentierendes Signal als Input für die Aufzugssteuerung.

WO 01/83350 A1

LOAD CARRYING MEANS FOR CABLE ELEVATORS WITH INTEGRATED LOAD MEASURING EQUIPMENT

FIELD OF THE INVENTION

The present invention relates to load carrying means for cable elevators with integrated load measuring equipment, in which the weight force of the load carrying means and useful load causes load-proportional deformation of at least one resilient element, wherein at least one sensor detects this deformation and produces, at an elevator control, a signal representing the strength of the deformation and thus the load.

BACKGROUND OF THE INVENTION

Load measuring equipment for load carrying means of elevators have the task of preventing elevator travel with an impermissibly high load and of delivering, to the elevator control, data which enables it to react - independently of the instantaneous load state of the load carrying means - in suitable manner to call commands by elevator users.

EP 0 151 949 discloses load measuring equipment for an elevator which is based on the principle that the entire elevator car is supported in such a manner on at least four bending girders projecting from an elevator car base frame that these bending girders experience a load-proportional bending deflection. The bending deflection of each individual bending girder is detected by means of strain gauges. All strain gauges form in common a measurement bridge which delivers a load-proportional analog signal to the elevator control.

The described load measuring equipment has some disadvantages.

The measuring principle requires four bending girders each equipped with a respective strain gauge or two respective strain gauges, wherein the mechanical tolerances of the bending girders as well as the resistance tolerances and mounting tolerances of the strain gauges have to be closely limited in such a manner that all four bending sensors have the resistance values for the same loads. All four or eight strain gauges have to be individually connected with a central evaluating circuit, which occasions substantial cost. Moreover, the four force introduction points between the base of the elevator car and the bending girders have to be so adjusted in vertical direction, when being mounted, that an acceptable force distribution is ensured.

Document EP 0983957 A2 discloses an elevator car arrangement wherein the elevator cage is supported on a base section that extends in widthward direction of the cage and which is configured to mount two cable sheaves at opposite ends thereof to provide a guided cable undersling arrangement of the elevator. Rubber elastic elements are disposed between the cage and the base so as to attenuate vibration transferred to the cage. A deformation sensor is installed between the base and the elevator car so as to detect deformation of the elastic elements and transmit a signal representative thereof to an elevator controller which thus is able to calculate a load of the cage.

One disadvantage with this arrangement is that a higher degree of signal processing is required by the evaluating circuit, given that vibration-induced, short term loads are overlaid onto the dead weight signal component which the rubber-elastic elements provide. Also, in this arrangement, the sensor signal is representative of the cage load and not of the entire elevator car (*ie* cage plus base section).

In light of the above shortcomings, it would be desirable to create simple and economic load measuring equipment for load carrying means of elevators with an underslung cable drive, which alleviates or lacks the above-mentioned disadvantages.

SUMMARY OF THE INVENTION

In accordance with the present invention there is provided load carrying means for cable elevators with integrated load measuring equipment, the load carrying means being of a type that is guidable at vertical guide rails and is suspendable for raising and lowering at a support cable arranged in the form of a cable undersling, including an elevator car structure and a cable guide roller support structure, the support cable being guided under the load carrying means at two cable rollers which are mounted underneath the load carrying means on the support structure, the support structure being fastened to the elevator car optionally through vibration-isolating elements, the arrangement being such that the weight force of the load carrying means and useful load carried by it may cause load-proportional deformation of at least one resilient load detection element, at least one sensor being provided to detect the load-proportional deformation and produce, as an input for an elevator control, a signal representing the extent of the deformation and thus

COMS ID No: SBMI-02860191 Received by IP Australia: Time (H:m) 16:17 Date (Y-M-d) 2006-03-03

the load, wherein a structural component of the support structure provides the load detection element, and wherein the cable rollers are mounted to the structural component in such locations where the load-dependent cable forces acting on the rollers impart a measurable deformation onto the structural component.

In accordance with another aspect of the invention there is provided a load carrying means for cable elevators with integrated load measuring equipment, including:

a support construction adapted to be attached to an underside of an elevator car and including at least one resilient structural component;

a pair of cable rollers positioned below said support construction, at least one of said cable rollers being mounted at said resilient structural component; and

a sensor means mounted on said support construction for sensing either bending or twisting of said resilient structural component whereby when said support construction is attached to the underside of the elevator car and said cable rollers are engaged by a support cable supporting and underslinging the elevator car, said resilient structural component may either be bent or twisted by load-dependent cable forces acting on said resilient structural component through said at least one cable roller.

The arrangement according to the invention, for cable elevators with integrated load measuring equipment, has significant advantages. Detection of the total weight of the load carrying means, and thus not also of the useful load, can be carried out by means of a single sensor, wherein even eccentrically disposed useful loads are correctly detected by such device. This measure saves costs for further sensors, for the wiring thereof and for the complicated signal evaluation thereof. The resilient load detection element, the deformation of which - caused by the weight of the entire load carrying means - is detected by the sensor, is a structural component of the support structure by which the cable rollers are fastened to the load carrying means. Consequently, substantially no additional mechanical constructional elements and no additional insulation space are needed for the load measuring equipment.

The structural component (*ie* the resilient element), the load-dependent deformation of which is detected by the sensor, can be conceived for different forms of loading, i.e. it can be designed as, for example, a bending girder, a tension/compression rod, a torsion rod or, for attainment of greater deformation distance, a compression, tension or torsion

COMS ID No: SBMI-02860191 Received by IP Australia: Time (H:m) 16:17 Date (Y-M-d) 2006-03-03

spring. Thus, load measuring equipment optimally adapted to different forms of load carrying means can be constructed.

Advantageous and economic embodiments of the load carrying means according to the invention with integrated loading measuring equipment can be achieved through use of sensor principles adapted to geometric relationships, environmental influences and, in particular, demands on accuracy. The invention permits use of diverse sensors for deformation detection, such as, for example, strain gauges, vibrating string sensors, opto-electrical distance or angle sensors and inductively or capacitively functioning distance sensors.

Depending on the form of load carrying means it can be advantageous to allow the two cable rollers mounted below the load carrying means to act directly on a common structural component. The advantages can be a symmetrical, simple execution of the support structure between cable rollers and load carrying means for improved deformation measurement capabilities.

In the case of restrictive geometric relationships in the vicinity of the underlying cable rollers or in the case of selection of specific forms of sensor it can be advantageous to allow only one of the two cable rollers to act on the structural component for load-dependent deformation detection. The support structures for the two cable rollers can in that case be executed as separate and differently formed units and no mechanical connections between these units are required. Such embodiments are made possible in underslung support cable arrangements, given that both cable rollers always experience the same loading through the cable.

Load carrying means for greater loads are usually equipped with a carrier frame. In the case of such embodiments it is generally of advantage to fasten the support structure, which contains the resilient element and which supports the cable rollers, to this carrier frame.

In the case of load carrier means for smaller useful loads, these can be executed as a self-supporting unit. The support structure carrying the cable rollers and containing the resilient element is in that case in advantageous manner fastened directly to the base construction of the load carrying means.

COMS ID No: SBMI-02860191 Received by IP Australia: Time (H:m) 16:17 Date (Y-M-d) 2006-03-03

In order to reduce the transmission of vibrations and sound waves from the support cables to the load carrying means it is advantageous to arrange isolating elements between the load carrying means and the support structure for the cable rollers.

The above, as well as other advantages of the present invention will become readily apparent to those skilled in the art from the following description of a preferred embodiment when considered in light of the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a schematic view of a load carrying means installation without a carrier frame and with a first embodiment of an integrated load measuring equipment according to the present invention;,

Fig. 2 is a schematic view of a load carrying means installation without a carrier frame and with a second embodiment of an integrated load measuring equipment according to the present invention; and

Fig. 3 is a schematic view of a load carrying means installation without a carrier frame and with a third embodiment of an integrated load measuring equipment according to the present invention..

DESCRIPTION OF PREFERRED EMBODIMENTS

A load carrying means 1 in accordance with the invention, without a carrier frame, is illustrated in Fig. 1 together with the elevator components most important for its function. Two guide rails, at which the load carrying means is vertically guided by means of slide or roller guide shoes 3, are denoted by 2. This load carrying means essentially consists of a base frame 4 with a base plate 5, a car 6 installed thereon, the said slide or roller guide shoes 3 and two cable rollers 9 fastened to the base frame 4 by means of a support structure 7 by way of resilient, vibration-isolating elements 8. The support structure (or construction) 7 consists of a bending girder 7.1 and two cable roller supports 7.2. Also recognisable is a support cable 10, which is led from a cable fixing point 11 vertically downwardly, then horizontally through below the cable rollers 9 of the load carrying means 1 and subsequently vertically upwardly to a drive pulley 12 of an elevator drive engine 13. The further course of the support cable 10 from the drive pulley 12 downwardly to a

COMS ID No: SBMI-02860191 Received by IP Australia: Time (H m) 16:17 Date (Y-M-d) 2006-03-03

deflecting pulley mounted at a counterweight and from there upwardly to a second cable fixing point is not illustrated here.

A vertical and a horizontal load-proportional cable tension force acts on each of the two cable rollers 9. The arrows 14 symbolise the cable rollers loads acting on the cable rollers 9 and thus on the support construction 7 and resulting from the cable tension forces of the support cable. It is readily recognisable that these resultants produce a bending moment in the bending girder 7.1 of the support construction 7 and thus a bending deflection. This bending deflection is detected by a bending sensor 15, for example a strain gauge sensor, which is not explained here in more detail and which produces, as an input for an elevator control, a signal corresponding with the strength of the bending deflection and thus with the overall weight of the load carrying means 1.

A second variant of the loading carrying means according to the invention with integrated load measuring equipment is illustrated in Fig. 2. The load carrying means 1 guided at the guide rails 2 by means of a slide or roller guide shoe 3, together with base frame 4, base plate 5 and car 6, are recognisable. The support construction 7 supporting the cable rollers 9 essentially consists of a fastening carrier 17, which is mounted at the base frame 4 by way of resilient isolating elements 8, and two cable roller supports 18. The cable roller support, which is not illustrated and is arranged on the right, corresponds with the cable roller supports according to Fig. 1. The cable roller support 18 at the lefthand side is pivotably fastened to the fastening carrier 17 by means of a bending element 19 and supported relative to the carrier by way of a pressure sensor 16. The pivot mounting of the cable roller support 18 could obviously also be achieved by a pivot axle. The cable roller load 14 resulting from the cable tension forces of the support cable causes a load-proportional pressure force on the pressure sensor 16, which also forms the resilient element and which produces a signal, which corresponds with the total weight of the load carrying means 1, as an input for an elevator control. The pressure sensor can be executed as, for example, a piezoelectric element, a capacitive sensor or a strain gauge element.

Fig. 3 shows a third variant of the load carrying means according to the invention with integrated load measuring equipment. The load carrying means 1 guided at guide rails 2 by means of a guide or roller guide shoe 3, together with base frame 4, base plate 5 and car 6, are again recognisable. The support construction 7 supporting the cable rollers 9

COMS ID No: SBMI-02860191 Received by IP Australia: Time (H:m) 16:17 Date (Y-M-d) 2006-03-03

essentially consists of a [fastening support 17], which is mounted at the base frame 4 by way of resilient isolating elements 18, with a lefthand bearing support 20 and two cable roller supports. The cable roller support, which is arranged on the right and not illustrated here, corresponds with the cable roller supports according to Fig. 1. The lefthand cable roller support 21, which is shown here and constructed as a pivot lever, is fastened to a torsion rod 22 and rotatably mounted by way of this in the bearing support 20 connected with the fastening support 17. An abutment 23 prevents overloads of the torsion rod 22. This is prolonged rearwardly beyond the bearing support 20 (into the plane of the drawing) and connected at its rearward end with the fastening support 17 to be secure against relative rotation. The cable roller load 14 resulting from the cable tension forces of the support cable produces, by way of the cable roller support 21 constructed as a pivot lever, a load-proportional torque which twists the torsion rod 22 and induces corresponding load-proportional torsional stresses therein. In its region lying free, i.e. between the bearing support 20 and its rearward fastening, the torsion rod is equipped at its surface with a torsional stress sensor in the form of strain gauges, with the help of which the torsional stresses and thus the torque are detected and a signal corresponding with the total weight of the load carrying means 1 is produced as an input for an elevator control. Obviously usual commercial torque measuring apparatus based on different measurement principles can also be used as torque sensor.

The claims defining the invention are as follows:

1. Load carrying means for cable elevators with integrated load measuring equipment, the load carrying means being of a type that is guidable at vertical guide rails and is suspendable for raising and lowering at a support cable arranged in the form of a cable undersling, including an elevator car structure and a cable guide roller support structure, the support cable being guided under the load carrying means at two cable rollers which are mounted underneath the load carrying means on the support structure, the support structure being fastened to the elevator car optionally through vibration-isolating elements, the arrangement being such that the weight force of the load carrying means and useful load carried by it may cause load-proportional deformation of at least one resilient load detection element, at least one sensor being provided to detect the load-proportional deformation and produce, as an input for an elevator control, a signal representing the extent of the deformation and thus the load, wherein a structural component of the support structure provides the load detection element, and wherein the cable rollers are mounted to the structural component in such locations where the load-dependent cable forces acting on the rollers impart a measurable deformation onto the structural component.

2. Load carrying means according to claim 1, wherein the structural component is a U-profile section with a web, which in use of the support structure extends horizontally, and two downwardly directed limbs, and wherein a respective one of the cable rollers is mounted at respective opposite ends of one of the limbs such that the load-dependent cable forces transmitted by the rollers to the limbs will impart a load-dependent bending of the web of the structural component.

3. Load carrying means according to claim 2, wherein the sensor detecting the load-dependent bending is mounted on the web of the structural component.

4. Load carrying means according to any one of claims 1 to 3, wherein the support structure is fastened to a carrier frame of the elevator car.

5. Load carrying means according to any one of claims 1 to 3, wherein the support structure is fastened to a base of the elevator car which is of self-supporting construction.

COMS ID No: SBMI-02860191 Received by IP Australia: Time (H:m) 16:17 Date (Y-M-d) 2006-03-03

6. Load carrying means according to claim 4 or 5, wherein the resilient, vibration-isolating elements provide a connection between the support structure and the carrier frame or the base of the elevator car, as the case may be.

7. A load carrying means for cable elevators with integrated load measuring equipment, including:

a support construction adapted to be attached to an underside of an elevator car and including at least one resilient structural component;

a pair of cable rollers positioned below said support construction, at least one of said cable rollers being mounted at said resilient structural component; and

a sensor means mounted on said support construction for sensing either bending or twisting of said resilient structural component whereby when said support construction is attached to the underside of the elevator car and said cable rollers are engaged by a support cable supporting and underslinging the elevator car, said resilient structural component may either be bent or twisted by load-dependent cable forces acting on said resilient structural component through said at least one cable roller.

8. The load carrying means according to claim 7, wherein said resilient structural component is a bending girder, a bending element or a torsion rod.

9. The load carrying means according to claim 7 or 8, wherein said resilient structural component is a bending girder or a bending element, and said sensor means is either a strain gauge sensor, a piezoelectric sensor or a capacitive sensor.

10. The load carrying means according to claim 7 or 8, wherein said resilient structural component is a torsion rod and said sensor means is a torque sensor.

11. The load carrying means according to any one of claims 7 to 10, wherein said cable rollers are mounted to said support construction such that the load-dependent forces act on the resilient structural component through both of said cable rollers.

12. The load carrying means according to any one of claims 7 to 11, wherein said support construction is adapted to be fastened to a carrier frame, of or for the elevator car.

COMS ID No: SBMI-02860191 Received by IP Australia: Time (H:m) 16:17 Date (Y-M-d) 2006-03-03

13. The load carrying means according to any one of claims 7 to 12, including a base frame for attachment to a bottom of the elevator car, and wherein said support construction is attached to said base frame by resilient, vibration-isolating elements.

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Fig. 1

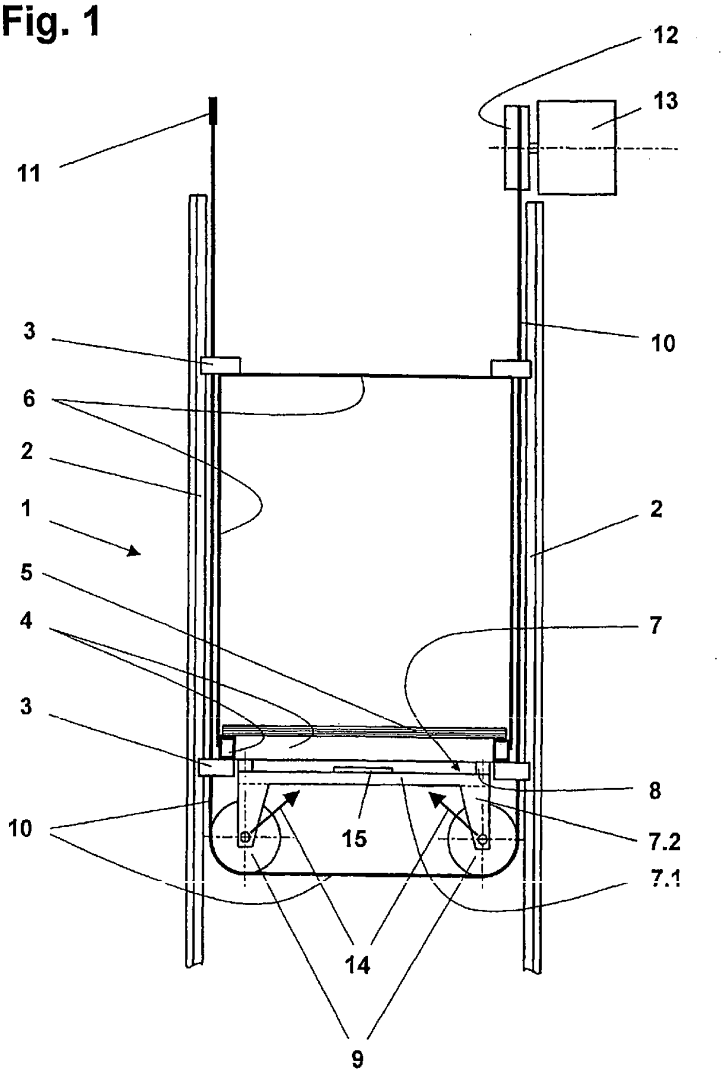

Fig. 2

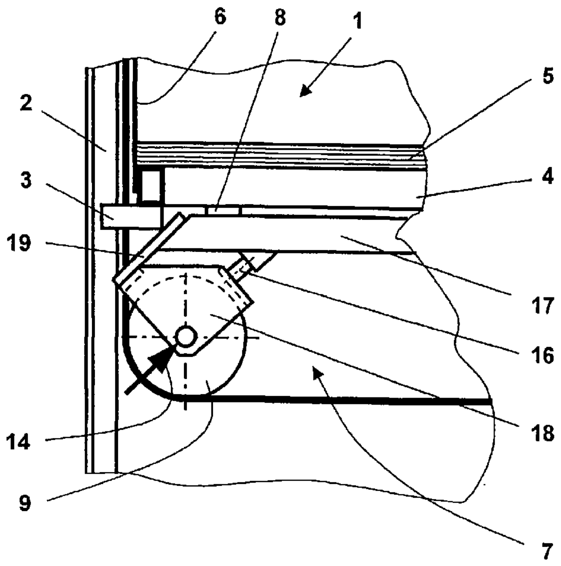

Fig. 3